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Chemical Industry on the Continent

A REPORT

To the Electors to the Gartside Scholarships

BY

HAROLD BARON, B.Sc.

Gartside Scholar

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THE GARTSIDE REPORTS.

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PREFACE.

THE following report is the outcome of an investigation of the chemical industries on the Continent and contains the results of a tour undertaken from May, 1905, until December of the same year, supplemented by subsequent studies. During this period works were visited in Belgium, Northern France, and Germany. The chapter on patent protection is based on the writer's observations whilst working in Berlin and London since the tenure of the scholarship.

Although the chemical industries in the broad sense of the term are dealt with in these pages, it will be found that the manufacture of aniline colours and dyeing has received more detailed consideration. This is due to the writer's particular interest at that time in this branch and the greater facilities he had for visiting works of this character. On the other hand some branches of chemical industry have not been considered at all owing to difficulty of obtaining information and the scattered location of the works.

The writer found that manufacturers were generally willing to allow their works to be inspected after the object in view had been explained. In cases where permission to view the works was withheld it was often possible to obtain much useful information in conversation with the responsible heads of firms.

The author wishes to express his thanks to Professor

S. J. Chapman for much encouragement and help during the progress of the work, to Professor W. A. Bone, F.R.S., and the late Mr. Bennett H. Brough for introduction to an important steel works in Germany, to Mr. Walker, His Britannic Majesty's Vice-Consul in Lille, for much assistance in visiting works in France, and to the Farbenfabriken Friedr. Bayer & Co., the Manchester Chamber of Commerce, Dr. C. Richard Böhm of Berlin, and the numerous managers of works and others who gave him facilities for obtaining practical information with regard to the subject of his studies.

DULWICH,

October, 1908.

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Chemical Industry on the
Continent.

CHAPTER I.

INDUSTRIAL DEVELOPMENT IN BELGIUM.

Principal Industries and their location—Liège and the Valley of the Meuse—The Société Anonyme John Cockerill—The Liège Exhibition of 1905—Locomotives on the Belgian State Railways—The Chemical Section at the Liège Exhibition.

ALTHOUGH Belgium is one of the smallest states in Europe, its manufactures are of great importance, and the exports per head of population exceed those of any other civilized country. It is very densely populated, and being particularly rich in minerals and inhabited by people of great industrial activity, a study of its economic conditions reveals many surprises to the observer.

The chief industries of the country comprise the following:—Coal; iron and steel; other metals; locomotives and machinery; glass, cement, textiles and artificial silk, and others of less importance. The coal districts lie in the neighbourhood of Mons, Charleroi, Liège and Seraing. Iron and steel and minerals in general are produced in the neighbourhood of Liège. The woollen industry is at Verviers, and the cotton industry at Ghent. Dyeing, the principal chemical industry associated with textiles, is carried on at both these towns. The important artificial silk factory of Tubize has a reputation extending beyond the frontiers of Belgium.

In the immediate vicinity of Liège there are a number of iron works of great importance. Products of these works consist of steel rails, girders, locomotives,

machinery of the heavy type, rifles, revolvers, etc. Ghent is well known for its iron works and cotton industry, besides being a horticultural centre. Cement works exist in various parts of the country, most of them being comprised in a syndicate with headquarters in Brussels, from whence production and export are regulated. There are also a number of alkali works of importance. These are controlled by the Solvay Syndicate, manufacturing according to the ammonia soda process also used by the large and important works of Brunner, Mond & Co. in Cheshire. The manufacture of fine chemicals is not carried on in Belgium to any great extent, and in this respect cannot compare, for instance, with the chemical industry of Germany, but a small aniline colour works is operated successfully near Brussels. In Brussels itself there is also a small and well-organized factory, manufacturing medicinal products.

Liège is situated in the centre of a very important coal-mining and mineral district. There are many large firms located on the banks of the river Meuse whose products are well-known outside Belgium. There are, for instance, the Société Anonyme John Cockerill at Seraing, the Société Anonyme St. Leonard, the Société Anonyme La Marihaye, the Société Anonyme La Meuse, and others. The Société Anonyme John Cockerill build bridges, locomotives, ships, and other steel constructions of this nature. They are also producers in a large way of steel rails, armour plates and machinery. The products are very similar to those of Messrs. Krupp of Essen, although the latter firm are much larger than the Société Anonyme John Cockerill. The John Cockerill works employed, in 1905, about 10,000 to 12,000 workmen. The works are situated at Seraing, about five miles higher up the River Meuse than Liège, the population being about 35,000 almost entirely dependent on the firm of Cockerill. Another

large iron works, situated between Seraing and Liège, is that of La Marihaye. Here there are blast furnaces producing pig iron and Bessemer furnaces for manufacturing basic steel. The products of this works consist of steel rails, "I" beams, girders for bridge construction and steelwork of this nature. England is an important market for the produce of Belgian iron works.

The International Exhibition held at Liège in 1905 afforded the visitor an excellent opportunity of gathering some idea of the industries of Belgium. Brussels is the metropolis of Belgium and the seat of Government, Antwerp is the commercial and shipping centre, but Liège is the industrial centre of a large manufacturing community. In the Belgian section of the Liège Exhibition the machinery hall constituted the most important exhibit. The largest individual exhibit was that of the Société Anonyme John Cockerill, the important firm founded by John Cockerill, a man of Yorkshire extraction at the beginning of the 19th century. This firm has risen to such eminence that it is only exceeded in importance on the Continent by Krupp at Essen and by Creusot in France. From the workshops of John Cockerill in 1835 came the first locomotive which ran on the Continental railways, and it is interesting to note that it ran on rails produced by the same firm. There are now many firms in Belgium who manufacture locomotives. The Belgian State Railways appear to distribute their orders for locomotives among a number of Belgian manufacturers, and in travelling about the country one notices the name-plates of many firms on the engines. Perhaps the name of John Cockerill appears most frequently. No imported locomotives were seen anywhere in the country, although at Maestricht, across the Dutch frontier, the name of a well-known English firm was in evidence. The international express trains which meet the boats at Ostend are usually provided with one or more coaches of the International Sleeping Car

Company. This firm was exhibiting at the Liège Exhibition a fine example of their "trains de luxe" such as are used in the European express services.

In bridge building, steel rails, and light railway material Belgium is strong, and the export of rails, girders, fish plates, etc., is very considerable.

Other important firms represented at the Exhibition were the Société Anonyme St. Leonard, Société Anonyme La Meuse—both of which firms are located at Liège—and Carels Frères and Phoenix—both of Ghent. In the Machinery Hall an imposing show was also made by the German and French firms. British and American firms were only represented in a small way.

In the chemical section, although a large number of firms were represented, the exhibits consisted merely of samples of their products enclosed in show cases. Exhibits were shown by, amongst others, the Papeteries Godin, the well-known paper manufacturers, the Remy starch people of Louvain, the Société Anonyme des Produits Refractaires et Terres Plastiques of Seilles-lez-Audenne, who had an imposing exhibit of acid-proof stoneware and artificial stone for ornamental purposes. The Portland Cement Syndicate also had a large stand, and a very interesting and well-arranged exhibit was provided by the Fabrique de la Soie Artificielle de Tubize.

CHAPTER II.

THE BELGIAN TEXTILE INDUSTRIES.

Sub-division of labour in Belgium not greatly developed—
The Société Anonyme de Loth—Société Anonyme
de la Vesdre.

THE principal characteristic of the textile industry in the North of England is the fine sub-division of labour. One factory will not only confine itself to spinning and another to weaving, but each will spin a particular range of yarn, or weave a certain limited range of cloth. This fine sub-division of the industry is not met with to anything like the same extent on the Continent. In Belgium, although a certain amount of division of labour exists, nevertheless the majority of the factories are self-contained, and there are many who buy the raw material, cotton or wool, and convert it by successive stages to cloth. A place of this character is the Société Anonyme de Loth, near Brussels. It is situated about twelve miles outside Brussels in the direction of Namur, and is engaged in the manufacture of woollen goods. This firm do both spinning and weaving, and sometimes also their own dyeing, but when the works was visited no dyeing of delicate or difficult shades was seen. The raw wool is all bought in London, and comprises the Australian and Argentine varieties. Besides being manufacturers, this firm are also merchants, and export to Spain, the United States, and South America, but not to England. Presumably the high sub-division of the woollen industry in Yorkshire permits the Yorkshire manufacturers to compete advantageously with such a Continental factory as the one under review, in which all

the operations are carried out in one and the same establishment. Much of the machinery used was English, Bradford, Keighley and Preston manufacturers being represented. There were also some Mulhouse and Saône machines. The operations carried out in this factory were as follows: the raw wool was first washed in a long series of tanks in which the wool was raked along on to rollers, from which it proceeded to the next tank. After drying the wool was combed so as to form a thick cable. It was then wound crosswise on large bobbins, the cables being then combined and twisted so as to form a single rope on one bobbin. It was then spun into the form of thread. In the weaving shed women were employed, earning about two francs per day, superintending two machines, having young girls as learners looking after single machines. There were small sheds attached to the works for dyeing blacks and dark shades with simple machinery. In the finishing room the presses were heated by steam. The nap was removed from the cloth by knives and rollers, a roller brush being used to remove dust. Large stenters were in operation in which the cloth passed both underneath and over the machine, thus economizing space. The stenter was provided with pins and not clips. The engine was a large double cylinder machine of 700 horsepower, manufactured by Carels Frères of Ghent, driving a dynamo by means of cable. This firm employed about 2,000 hands. The locality of the Société Anonyme de Loth, away from Verviers, the centre of industry, probably accounts for so many operations being carried on in one and the same factory. In Verviers and other centres there is more sub-division of labour.

At Verviers the Société Anonyme de la Vesdre was visited. This company employs about 700 hands, the capital being about Frs. 1,500,000 of ordinary shares and the same amount of debentures. The factory is occupied in carrying out the following operations in connection

with the manufacture of wool: Washing, extraction of suint, carding, combing, bleaching, dyeing, slopping-printing, and spinning. Like the other works in the Verviers district, excellent water is provided from the reservoir of La Gileppe. This very extensive reservoir supplies the Verviers district with water of a particularly good quality which requires no special treatment before use in the boilers. A special feature of the La Vesdre factory was the excellent arrangement and hygienic conditions of the establishment. There were two steam engines of 450 and 650 H.P. capacity respectively manufactured by Bollinckx of Brussels, one being used for the combing department and one for the spinning. At the time that the factory was visited, the wool trade in Verviers was flourishing. The factory of La Vesdre deal extensively in carded and combed wool, exporting particularly to Germany. They also comb for their own spinning requirements. A large quantity of raw wool, Australian and Argentine was observed in the store-room.

CHAPTER III.

THE CHEMICAL INDUSTRIES IN BELGIUM.

Aniline colours—Destrée Wiescher & Co.—New System of Hank Dyeing—Laboratoires Optima in Brussels—Sterilising medicinal products—The manufacture of lint—Artificial silk—Société Anonyme de la Soie Artificielle de Tubize—Profits from artificial silk—Portland cement—The Cement Syndicate in Belgium—Extension of Antwerp Docks.

THE manufacture of fine chemical products is not carried out to any large extent in Belgium, and therefore will not bear comparison with that of Germany. Two factories were visited in this branch. One of these was a works producing aniline colours, Destrée, Wiescher & Co., located at Haren Nord, near Brussels. This firm appeared to do a considerable trade in mixing aniline dyes bought from German manufacturers. It sometimes occurs that dyers and calico printers demand colours of a particular shade in order that the operation of dyeing may be simplified, and there is a considerable opening for works competent to mix the dyes so that the desired shade may be produced without it being necessary for the dyer himself to do his own mixing. The Haren firm would appear to do a considerable business in this direction for Belgian dyers, and in fact English dyers also. Besides aniline colours a considerable quantity of ultramarine is also produced. Some of the large combines in the North of England were important customers of this firm. There was also a considerable export trade done to India. A particular feature of interest in connection with this works, however, was a

new type of hank dyeing initiated and developed by the firm. The machine is intended for dyeing hanks mechanically, an operation which is usually done by hand. The hanks are rigged on frames and are connected together in such a way as to form a complete chain of hanks, each section being composed of about a dozen parallel hanks. This is dyed in the machine, which in operation resembles an ordinary dye jigger. The chain of hanks with the frames is passed over rollers through the dye baths and emerges through squeezing rollers, and may be dried in position on the frames.*

Another place visited was the Laboratoires Optima, situated in Schaerbeek, near Brussels. It is a Société Anonyme with 1,000,000 francs capital, occupying new premises erected in 1902. This is a very well conducted works, and the class of products is similar in nature to those produced by Burroughs Wellcome & Co. in England, and Messrs. Bayer & Co., and others in Germany. These products comprise serums and medicinal extracts of various kinds, such as morphia and strychnine. The firm makes a speciality in sterilized products. Their customers include the hospitals, the Army, the railways administration and pharmaceutical chemists. In 1905 they did not occupy themselves with the export trade, since they would have to compete with large and old-established firms. An apparatus was inspected for sterilizing in the cold with carbonic acid at a pressure of 50 atmospheres. This is required for a certain type of serums. There was also an ingenious apparatus for sterilizing at 100°C. at a pressure of 150 atmospheres. In this case the product is sealed up in a glass tube leaving an air space. The sealed tubes are placed in a closed vessel containing water, and heated to 100°C. The pressure on the outside of the tube

* A complete account of this system of dyeing was published in the *Textile Recorder* for August, 1905.

compensates for the pressure inside the tubes so that liability of breakage is prevented. This method of sterilizing is said to give excellent results, and a very similar method was seen in Germany at a large brewery where bottled beer was sterilized for export to the tropics. The filtration of the various serums was effected in small presses containing about fifty filter papers.

This firm manufacture sterilized lint in large quantities. This is usually first immersed in a bath containing phenol and dried in an oven of special construction. It can also be sterilized by heating with superheated steam at 105°C . in an autoclave. For carrying the lint small waggons were used, which can be run into the autoclave with the charge of lint much in the same manner as the well-known "Mather Bleach" apparatus.

Another simple method of sterilizing is to heat up a package of the lint in tin boxes. These can then be closed without it being necessary to touch the lint with the hand. Much business is done in the manufacture of medicinal products in tablet form. The factory was excellently fitted up, each room being reserved for its special apparatus and manufacture, and suites of rooms arranged for a certain class of work, being completely separated from other suites used for different work. The employees were mostly girls dressed in neat overalls, and the writer was informed that they give greater satisfaction in work of this type than men on account of the careful manipulation necessary, and because lower wages can be paid.

Artificial silk is a product which has engaged the attention of chemists for many years, but it is only within recent years that it has been manufactured in large quantities. An attempt was made some years ago to manufacture artificial silk by the "Viscose" method in England, but the attempt was not attended with commercial success. It has been left to Continental manufacturers to evolve a successful industry in this

branch. The method generally employed on the Continent is the Chardonnet process. In this method cotton is dissolved in a mixture of nitric and sulphuric acids forming nitrated cellulose. This is dissolved in alcohol and ether, and the resulting solution of collodion is squirted through fine capillary tubes of glass so as to form threads. These are twisted or spun, if necessary, to give the required strength. They are then passed through a denitration process in order to render them less inflammable. This product is extensively used as a substitute for silk. Although it compares unfavourably with natural silk in point of strength and durability, it is superior to the latter in brilliancy of appearance. A type of artificial silk which has become very important consists of threads of large cross section resembling mohair. This is used in manufacturing braids, ribbons and trimmings, and the manufacture of this product on the Continent is said to have greatly injured the Yorkshire mohair trade.

A very successful factory producing artificial silk in Belgium is the Société Anonyme la Soie Artificielle de Tubize. Every endeavour was made to obtain permission to visit this factory, but without success. However, the management at Brussels courteously gave some particulars regarding the success of the industry. This firm commenced operations about the year 1900, and within five years practically recovered in profits the whole of the original outlay of capital. Both in Belgium and Germany the principal firms associated with the manufacture of artificial silk have been phenomenally successful. One of the latest applications of artificial silk has been in the manufacture of incandescent gas mantles by the "Cero-firm" process.

An important industry in Belgium is the manufacture of Portland Cement. There are, broadly speaking, three kinds of cement—natural cement, iron cement and artificial or Portland cement. All these grades are

produced in Belgium. The natural cement is found in the neighbourhood of Tournai. The deposit is simply dried and pulverized. Its value or grade is determined by chemical analysis and tests. In comparison with ordinary Portland cement the natural variety is not of great value. Iron cement is made from the slag produced as a bye-product in iron works. It finds a use in the making of pavement-blocks. Artificial or Portland cement is produced from clay and chalk. These are mixed, the resulting product being dried and afterwards burnt. The clinkers thus formed are pulverized and the product sold as Portland cement.

A considerable number of cement works exist in Belgium, and for the purpose of regulating the output are united in a syndicate with headquarters at Brussels. The combine is known as the Société Anonyme de Ciment Portland de Belgique. They had an imposing show at the Liège Exhibition. The output of Belgium in this branch amounts to about 700,000 tons annually, and as the home consumption only disposes of about 100,000 tons per annum, there is a large surplus for export purposes. The firms united in the above syndicate have a convention with regard to the home supply, but for export purposes each firm acts independently. The syndicate does not control the export trade because, when originally formed, several firms having a large export trade would not share their advantage with other firms doing no export trade at all. Such, for instance, was the case with the North Portland Cement Works at Turnhout, near the Dutch frontier, with offices in Antwerp.

The writer interviewed some of the leading gentlemen at Brussels and Antwerp, and gathered that the trade at this period was in a prosperous state, the price at that time being Frs. 29 per ton. With regard to competition with English manufacturers, the freight between Belgium and England rendered export to England impossible.

There was competition, however, with British manufacturers in other markets.

In 1905 cement manufacturers in Belgium were considerably interested in the proposals which had been put forward for increasing the dock accommodation at Antwerp. It has been suggested that the course of the River Scheldt might with considerable advantage be altered so that the accommodation for shipping could be largely increased. Antwerp would thus be in a better position to compete with London and Hamburg for its share in the shipping of Northern Europe. The scheme would probably involve an outlay of about £5,000,000, and in the construction of the docks Portland cement would, of course, be extensively used. It is only natural, therefore, that the Portland cement manufacturers should be greatly interested in supporting this proposal of the city of Antwerp.

CHAPTER IV.

TEXTILE INDUSTRIES IN NORTHERN
FRANCE.

Location of the Textile Industries—The Motte family of Roubaix—The wool exchange—The Conditioning House—Hannart Frères—Vve. Gaydet et Fils—Système Vigoureux—Cop dyeing—Motte & Meillasoux—The smoke nuisance in Roubaix—Dyeworks of Emile Roussel—Wages in Roubaix—Indigo dyeing in Lille.

THE industrial activity of France is located as far as manufacture is concerned, in three principal districts. The centre of these districts are Paris, Lyons, and Lille. There are, of course, important industrial communities outside these districts, and there are the great vintage countries around Bordeaux and Rheims, but this investigation is limited to the Department of the Nord, and particularly to the industries situated in the vicinity of Lille, Roubaix and Tourcoing. In this district there are some highly important engineering, textile and chemical factories. In the textile industry, spinning and weaving of cotton, wool and linen is carried on. "Lisle" thread derives its name from its association with the town of Lille. The greater part of the linen industry, however, is located at Armentières. Some fine cotton spinning is carried on in the district, but woollen manufacture is of greater importance. The great centre for wool is Roubaix, which town has a just claim to be considered the French "Bradford."

In connection with the textile industries there are, of course, the important subsidiary chemical industries of

dyeing, printing and finishing, and it is to these that the attention of the writer was devoted more particularly.

Apart from the chemical industries associated with textiles, there are some chemical works, engaged in the manufacture of such products as alkali, sulphuric acid and superphosphate manures. A well-known firm of German colour manufacturers have a subsidiary establishment near Roubaix. There are also factories engaged in the refining of petrol and manufacture of potash salts. Other works confine themselves to the manufacture of the various chemicals used in the dyeing and finishing of textile goods, which branch is a large market for such products.

At Roubaix many of the woollen factories and dye-works are controlled by the Motte family. M. Eugene Motte, the head of the family, was, in 1905, Mayor of Roubaix, and a member of the *Chambre des Deputés* for that district. He himself is directly engaged in the spinning industry, but members of his family are directors in many of the large dye works and textile factories located throughout the district. Among the firms in which the Motte family are interested may be mentioned Motte et Meillassoux, and Motte et Defescluses, both of which firms are dyers and finishers. The textile industry in Roubaix appears to be well organized, and possesses a wool exchange and conditioning house besides a number of institutions controlling the interests either of the masters or the hands.

The Wool Exchange is a small building situated in the Central Square of the town, and although in size and appearance it is not imposing, a considerable amount of business is carried on there. The important Conditioning House is controlled by the Chamber of Commerce of Roubaix. The Conditioning House is a state institution under the control of the *Ministère de Commerce* at Paris, and its function is to regulate and control the contracts between buyers and sellers in regard to the quality of

goods. The textile products which come within the sphere of the Conditioning House are cotton, wool and silk, both in raw condition and in yarn. The price paid by the buyer to the seller is determined by the report of the Conditioning House. On visiting the institution no cloth or chemical products were to be seen being tested, but there was a large quantity of combed wool, wool and cotton yarn on cops, cotton in hanks and some silk.

It may be of interest to give some account of typical operations carried out in the Conditioning House at Roubaix. The system of testing combed wool is as follows:—Each bale is weighed and the tare of the cover cloth and packing deducted. Samples are taken for the purpose of estimating moisture. As all the bales are the same size, two tops are taken from each bale and about six hundred grams withdrawn from each, a length being taken from the centre and another from the outside. The price for estimating moisture is 9 francs per 1,000 kilos. of wool. This charge is usually divided by the vendor and purchaser.

Cotton, wool and other yarns are also tested for moisture in a similar manner, sample cops being taken for this purpose. Various particulars, such as strength of yarn, length of yarn on cop and elasticity can be determined, if necessary, but the most important factor is the moisture determination. The margin allowed for moisture in the Roubaix trade is as follows:—Wool, 18·25 per cent.; cotton, 8·5 per cent.; silk, 11 per cent. Large samples weighing 500 grams are suspended from one arm of a balance of precision in an oven heated by steam to 105° to 115°C. Here the hanks remain until there is no further decrease in weight. The percentage of moisture is calculated and the equivalent amount of wool with 18·25 per cent. of moisture determined. The ovens and balances were of excellent construction, the ovens being about four feet high, and the balances superimposed on the ovens another two or three feet. There

were 48 of these machines all of the same type in the moisture estimation room, and it was noticed that they were all of Roubaix construction. The estimation of moisture takes considerable time, and when work is particularly heavy the preliminary drying is usually carried out in a small oven of ordinary construction at a lower temperature, such as 90°C.

Perhaps the largest dye-works in the North of France is that of Hannart Frères at Wasquehal near Roubaix. This works is said to be one of the most important and best managed dyeworks in the world. The work is all piece dyeing, chiefly in the woollen branch. Although their customers are chiefly the merchants of Roubaix, a considerable amount of business is stated to be done, direct or indirect, with Bradford and Manchester. A laboratory is attached to the works, two Mulhouse chemists being employed. The firm are capable of dyeing 18,000 pieces per day, and apparently have a large turnover. It was found impossible to obtain permission to look over this establishment.

A large dye-works visited in Roubaix in July, 1905, was that of Vve. Gaydet et Fils. This works is occupied in the dyeing of combed wool by the slopping printing method which is known in France as the *Système Vigoureux*. The capital of this firm was Frs. 2,500,000, and the daily output amounted to about 20,000 kilos. In slopping printing the wool is printed rapidly in the form of a thick loose cable by means of ordinary copper rollers with oblique lines. In the subsequent spinning, the printed and unprinted parts of the woollen fibre mix and so form a greyish mixture, the shade being determined by the distance apart of the printing lines on the rollers. The *Système Vigoureux* was a speciality of Vve. Gaydet et Fils. Another feature of interest in this works was a special system of hank dyeing. The hanks were hung on a large frame holding about 200 hanks, and the whole was let down into a vat of the requisite size. The frame

with the hanks was put into motion by simple mechanism at the side of the vat, and even dyeing was assured without any great attention. The frame and mechanism being quite simple in construction, this method of dyeing was particularly economical.

The combed wool was dyed in the form of tops. Tops about one foot diameter were inserted in cylinders of slightly larger dimensions and the dye liquor forced through by means of pumps. A number of these cylinders were usually arranged on a single spindle in a vat of suitable size. The whole was covered with a thick cloth in order to prevent the dye liquor from spurting outside the machine on coming out of the cylinders. Vve. Gaydet and Fils are said to be the largest dyers of this particular class of work in the world. Dyeing of wool in the combed form is, for certain purposes, superior to piece dyeing, owing probably to the fact that wool in the loose form after combing takes the dye better than when the fibres are closely packed together as they are in cloth.

Another feature of interest in this factory was a system of cop dyeing for yarn, originated in Roubaix. M. Louis Dumons, the patentee of this method of cop dyeing, had an experimental plant in the works. The method consists in forcing the dye liquor at the right temperature with a perforated spindle through the mass of yarn by means of a pump. The system is reversible, the liquor being first forced from the outside into the core of the spool and then back again in the opposite direction. The cops are arranged to the number of several hundred round the central pipe connected with the automatic pump. The whole apparatus is very economical as regards space, and requires little or no attention during the actual dyeing operation. It was formerly a long operation to remove the cops from the spindles. This is now readily effected, the perforated spindles themselves being made detachable. The dyeing takes from half an

hour to two hours, according to circumstances. The colour takes very uniformly, and the dyeing is said to be superior to ordinary hank dyeing by hand. Vve. Gaydet and Fils intended to instal this system for the purpose of dyeing combed wool on the tops.

Another large works visited was that of Motte and Meillasoux. This firm undertakes bleaching, dyeing and finishing of cotton and wool in piece, cotton yarn in hanks and also raw cotton and wool. Some hank mercerizing is also carried out. Raw cotton and wool was dyed in vats, and during the process a couple of large rakes at each side of the vat kept the material in motion. Cotton yarn was dyed in hanks in the ordinary way by hand. For dyeing yarn black a machine was used which pumped the liquor continuously through the mass of yarn packed in a closed vessel.

A speciality of Motte and Meillasoux was the printing of woollen pieces with special designs, causing the cloth to look as though it had been woven from two different colours of yarn. The wool printing machines, of which three were working, were single colour machines. After printing the cloth passed slowly through a heated chamber, up and down, and finally came out dry. The drying chamber was of German manufacture, fitted with glass windows at each side so that progress in the interior could be watched.

The bleaching of woollen cloth was effected by means of hydrogen peroxide. Sodium peroxide was probably used for manufacturing the hydrogen peroxide. Wool bleaching is usually carried out by means of sulphur dioxide, but this method is not permitted by the municipal authorities of Roubaix on account of the annoyance caused thereby. Why the municipal authorities should be so strict on this particular subject when they apparently permit black smoke to emerge from the factory chimneys it is difficult to imagine. Some of the factories in Roubaix were great offenders in respect to the

emission of black smoke, but Motte and Meillasoux, being equipped with mechanical stokers, did not pollute the atmosphere like some of their neighbours. The bleaching of woollen cloth is usually only necessary when delicate shades are to be dyed. Before dyeing particulars are sewn on the end of each piece, and the whole length is passed through a washing bath. This removes much gum and sizing used by the weavers. Only easy dyeing colours were employed, Immedial Black being a favourite. Drying in some cases was carried out by revolving cylinders heated by waste steam, which was afterwards conducted away to the open air.

Another dye-works visited in Roubaix was that of Emile Roussel. This is a private firm like many others in Roubaix, but is comprised in the general Syndicate of French Dyers. Although this dye-works was not large, a considerable amount of work was done, especially in the summer seasons, dress goods for winter wear being an important feature of the business. The goods were mostly woollen of the shoddy type, some being entirely shoddy. Brown shoddy was only dyed in very dark shades. An interesting feature of the works was the system of pressing. The press-room plant was worth about 100,000 francs, the cardboard alone amounting in value to about 25,000 francs. The boards were passed through heated rollers and then laid by hand in the folds of cloth. The packed material was pressed with an ordinary hydraulic press for the requisite space of time, a pressure of about 350 kilos. per square centimetre being used. This firm had tried to introduce wool printing, but without success. Two printing machines had been installed but were now stopped. The experiment cost the firm about £2,000 in one year. The reason given for this loss was that in France the market for wool printers was not so large as in England, and it was continually necessary to change the rollers and colours executing small orders. It was therefore impossible to

carry on the business at a profit. Some of the cloth finished in this factory was exported to England, rolled on a wooden board, but for the French market the goods are merely folded and made up in packages about $\frac{1}{2}$ metre square. For each colour, special dyers were engaged, earning 40 to 50 francs per week, part of the wages being fixed and part commission per piece. There was also a head dyer with a salary fixed by agreement. Ordinary labourers received about five francs per day according to ability. M. Roussel informed the writer that he always engaged his men personally, and did not favour the trade union class, because, generally speaking, in Northern France the union men were difficult to deal with. The "Syndicat des Ouvriers Teinturiers et Apprêteurs de Roubaix et Environs" is the dyers' trade union for this district. It was said that this organization has a reputation for striking at the slightest pretext, and that their relations with the masters were anything but smooth.

In the textile district of North France most of the works are large concerns, and in this respect different from the dyers of Elberfeld and Barmen in Germany where many of the dyers are small proprietors employing less than a hundred men. One of the French dye-works visited, however, that of M. Obin, in the Rue des Stations, Lille, was of the latter type. It was devoted almost exclusively to indigo dyeing. In Lille and district much linen and cotton cloth is dyed with indigo because this material is used very largely by mechanics and artisans for working clothes. M. Obin's factory was an excellent example of the intelligent organization of manual labour on a comparatively small scale. In spite of the simple methods used and the comparative absence of machinery the results obtained were distinctly good, and M. Obin himself was an able chemist conversant with all the latest developments in dyeing. All the indigo used was synthetic indigo purchased from the German firms. It was sometimes bought in the form of

paste, but usually in the form of small granules which were ground into paste with water, the cost at that time being about 10 francs per kilo. of pure dry indigo. Before dyeing, the pieces were immersed in bundle form, in soaking baths made up of soda, caustic soda or malt fermentation liquor in order to remove the materials added to the cloth in weaving and to remove the pellicle peculiar to the fibre. It also served the purpose of thoroughly soaking the cloth with water in order that the dye may be taken evenly. The method of dyeing employed was to leave the pieces for a considerable period of time in indigo vats of a particular strength. The vats consisted of round brickwork pits sunk into the ground and lined with cement, dimensions being about four feet in diameter and six feet in depth. Ferrous sulphate and lime were used for dissolving the indigo. About 100 to 120 yards of material cotton or linen was attached in zigzag fashion to a wooden frame suspended over the vat from a pulley. The cloth was attached to the frame at the selvage on bent nails with which the frame was studded. This was let down so that the cloth was entirely immersed in the vat. In order to economize in dye-stuff, the cloth was first suspended in an almost exhausted bath for twelve hours, it being usual to leave the material in the vat overnight. The frame was then raised and the cloth left to the air in order to oxidize the indigo-white. The piece was then immersed in a bath of greater concentration for a further length of time, the process being repeated in accordance with the nature of the material and the depth of shade required. It may be mentioned here that linen is particularly difficult to dye with indigo, and it is necessary to alternately immerse the material in the vat and then leave it to oxidize in the air for four or five days. When the cloth has almost acquired the requisite depth of shade, it is finished off in a mechanical dyeing machine until the desired shade has been obtained. The concentration of indigo in these

machines was, of course, greater than in the standard immersion vats. After dyeing the cloth was treated in a bath containing hydrochloric acid, in order to remove the lime and oxides of iron, a final washing being necessary in order to remove the acid. This method of dyeing, although it requires a good deal of attention and manual labour, is said to give very fast shades. It is, of course, more expensive than ordinary mechanical dyeing.

The drying operation was carried out either at ordinary temperatures in a room provided with ample ventilation or in a heated drying chamber. In either case the cloth was suspended on rafters in a lofty room. Drying by ventilation is said to be better for linen cloth than the usual cylinder method because the linen thread is thicker in some places than in others, and when pressed by drying cylinders it becomes unevenly polished by contact with the metal. Moreover drying at ordinary temperature is preferable, because there is less risk of the cloth being "tendered" by any remaining acid. The cloth was dressed with the usual finishing materials, such as starch, gum, gelatine, dextrine, etc. Complying with merchants' instructions, a considerable amount of imitation work was executed; for instance, a piece would be partially dyed with indigo and then topped with a blue aniline colour, and afterwards passed through the indigo vat in order to give the appearance and odour associated with indigo. Sometimes "Bismarck Brown" was used to imitate indigo bronze. A special class of work was done in re-dyeing workmen's overalls, a charge of about 5d. or 6d. per garment being made.

A special machine employed at this factory was a large press performing an operation very similar to beetling. Rolls of cloth, after being dyed with indigo were placed under a wooden frame heavily weighted with cement blocks. By means of a lever attached to an engine this weighted frame was made to pass backwards and forwards so as to roll the cloth. This operation produced a polish equivalent to a beetle finish.

CHAPTER V.

CHEMICAL INDUSTRIES IN NORTHERN FRANCE.

Société Anonyme des Etablissements Kuhlmann—The contact process of sulphuric acid manufacture—**Eycken and Leroy**—Manufacture of sulphuric acid—Manufacture of bisulphite of calcium—Petrol refining—**Raffinerie de Petrole du Nord**—By-products from wool—Manufacture of potash salts—Beet sugar residues.

THE largest chemical works in the Department of the Nord is the Société Anonyme des Etablissements Kuhlmann. This firm was founded in 1830, and now controls a number of works, situated in the neighbourhood of Lille. The products manufactured include sulphuric acid, nitric and hydrochloric acids, superphosphate for agriculture, copper salts for the vine growers, and other chemicals of a similar nature. Carbonate of soda is no longer manufactured on account of the effective competition of other manufacturers employing the ammonia-soda process.

In 1905 Kuhlmann's were experimenting with the "Contact" process for manufacturing sulphuric acid, but from outside information it appeared that the results were not altogether satisfactory. The "Contact" process for manufacturing sulphuric acid was originally developed on a large scale a few years ago by the Badische Anilin und Soda Fabrik of Ludwigshafen, and consists in passing a mixture of sulphur dioxide and oxygen through heated chambers containing platinised

asbestos. The heated platinum acting as a catalytic agent effects the combination of the two gases producing sulphur trioxide which passes out of the chambers in the form of a fog. It is dissolved in sulphuric acid forming fuming sulphuric acid from which the sulphuric acid may readily be obtained by the addition of water.

Acids are not shipped to England from the North French works for several reasons, on the one hand they are difficult and awkward to transport causing freights to be high, and on the other hand English prices in such products are low. Moreover there is a good market in the district, especially among the numerous bleach and dye-works of the Department of the Nord.

The most interesting chemical works visited by the writer in Northern France was that of Eycken and Leroy at Wasquehal near Lille. This works is occupied in manufacturing numerous chemicals employed in bleaching and dyeing. These include acids, sulphates of soda, potash, and aluminium, bleaching powder, bleach liquor, acetic acid, barium peroxide, oxalic acid and oxalates, sulphates and bi-sulphites, silicates, etc. A portion of the works was not open to inspection because a number of processes were being used which were not protected by patents. It was possible, however, to make an inspection of the sulphuric acid plant and the plant devoted to the manufacture of heavy chemicals. The processes employed were superintended by a very able chemist who had received his scientific education in Mulhouse. The sulphuric acid plant was excellently equipped, being apparently more economical and better adapted for its purpose than the usual sulphuric acid works in operation in England. The lead chamber process was used, and the chief differences between the process as carried out here in North France, and the method usually adopted in England were as follows: Firstly, there were no nitre pots, 20% nitric acid being introduced at the top of the Glover Tower with the

mixture of chamber acid and Gay-Lussac acid. This allows of a better regulation of the nitrogen element than the older method involving the use of nitre pots. Secondly, all the chambers were covered with a substantial tile roof, and protected on the sides by wooden partitions. In this way, a more equable temperature is maintained and the production per diem does not depend upon the outside temperature, being practically the same both in winter and summer. Thirdly, atomized water was employed instead of steam. The water was introduced into the chamber under pressure through platinum jets which converted the water into a very fine spray. The water was first filtered and then pumped through the jets at a pressure of about 10 lbs. per sq. cm. Four or five of these jets were used for each of the first two chambers but no water was introduced into the third chamber. In order to introduce more water when necessary additional jets could be put into operation or the pump made to work at a higher pressure. However, there was an installation for introducing steam in case of breakdown of the atomized water installation. Fourthly, instead of ordinary pyrites kilns, the "tier system," consisting of superimposed shelves, was employed. The charge consisted of crushed pyrites and during the course of the burning the material was raked from the upper shelves to those below. The advantages of this process are greater regularity in working and higher output of acid per unit of chamber space. Fifthly, the gases from the chambers were pumped to the Gay-Lussac tower at a uniform velocity. A separate outlet direct to the Gay-Lussac was maintained in case of emergency resulting from breakdown of the pump. Sixthly, an improved method of concentration was used. The writer has been informed that although the Webb process of concentration is theoretically very economical, there is much trouble owing to the breakage of the glass vessels. If the glass vessels

are replaced by porcelain evaporating basins, this difficulty might be overcome. This was the process employed at Eycken & Leroy's works. The basins were arranged in an inclined flue made of stone. The stone flue was made of acid-proof material and the fire gases passed directly underneath, being afterwards led away under shallow lead evaporating troughs containing chamber acid. The chamber acid was led first into leaden troughs and then into the series of basins situated in the inclined acid-proof chamber. The acid running away from the bottom basin was of 97 to 98 per cent. strength which is the usual concentration obtained by other methods. The breakage of basins did not amount to more than one or two per month. The principal advantages of this method of concentration are economy in space and coal. Many of the improvements introduced into the manufacture of sulphuric acid in Northern France appear to be due in no small measure to the work of Paul Kestner. This gentleman is a well known chemical engineer in business in Lille who has made a special study of the chemical industries existing in North France.

In manufacturing nitric acid the distillation was carried out at ordinary atmospheric pressure. The vacuum process apparently did not meet with preference here. Condensation was effected by means of earthenware pipes cooled by water and pots cooled by air. Acids of all strengths were obtained, including water white nitric acid. Sulphate of soda was manufactured, according to the well known method with a closed muffle furnace, hydrochloric acid being obtained as a by-product.

The hydrochloric acid was condensed by passing the hot gases first into the series of earthenware vessels, and afterwards up two towers. From the muffle the hot gases passed first up two towers and then through the series of earthenware vessels. In transporting hydro-

chloric acid iron tanks lined with guttapercha were employed.

Bi-sulphite of calcium was manufactured by the following process. Sulphur dioxide was passed direct from the kilns into water from which it was boiled out so as to obtain it in a pure form and passed into water containing calcium carbonate in suspension. The sulphur dioxide acting on the calcium carbonate forms bi-sulphite of calcium and the clear liquor was decanted from the sediment. This liquor is much used in Northern France for bleaching and sugar refining. It is also used by brewers and others for arresting fermentation.

In order to give some idea of the output of a typical French chemical works the following figures representing the daily production of Messrs. Eycken & Leroy may be quoted.

Pure sulphuric acid.....	20,000 kilos.
Sodium sulphate	12,000 „
Calcium bi-sulphite liquor...	5,000 „

The nitrate of soda used amounted to 6,000 kilos per day. Most of the sulphuric acid manufactured was employed by the firm itself in producing alum and the various other chemicals. The bauxite used was obtained in France. Sodium nitrate was imported from Chili via Dunkirk. An electrolytic plant was employed for manufacturing caustic potash, sodium hypochlorite, etc. The power consumed by the electrolytic plant amounted to 300 horse power.

Each department of the works was under the control of a research chemist and the organisation appeared to be extremely good. The sulphuric acid plant had been working about five years, and the concentration plant about four years; oxalic acid was manufactured from potash and sawdust by a special method. Little export trade was done except with Belgium and Italy.

In considering the industries of North France, it must be remembered that an artificial situation is created by the fact that France has a protective tariff. By means of this tariff it has been possible to create industries in the country which would not otherwise exist. Petrol refining is one of these industries. Apparently petrol refining does not exist to any great extent in England or Germany and it is solely the French tariff which has created the industry in that country. On the crude petrol itself a small duty is levied for the purpose of registering the amount imported. On refined petrol the duty is sufficient to keep out foreign refined petrol and to make it pay to do the refining for the French market in the country itself. One of the petrol refining works, the Raffinerie de Petrole du Nord at Croix near Roubaix was visited by the author. The crude petroleum is obtained from America, Russia, and Roumania. The oil is imported in tank steamers and pumped at the harbour into tank waggons on rail. At Croix, the oil is led from the tank waggons on the rails direct into the works. In the works the transportation of the oil is always done by pipes. Most of the petrol refining works in France are syndicated for two purposes, namely, to regulate prices and by union to exercise sufficient pressure on the Government to keep the import duty of refined petrol at a figure sufficiently high to make the industry profitable.

In the distillation of crude petroleum the following fractions are distinguished :—

80° to 100°C. light petroleum or petrol for automobiles, gas engines, etc.

100° to 150°C. "Essence" a paraffin specially adapted for ordinary hand lamps, and

150° to 200°C. paraffin for ordinary lamps and lighting purposes.

Above 200°C. vaseline is obtained.

The product left in the retort consists of a carbonaceous

residue something like sugar carbon. It is used for manufacturing calcium carbide and some other purposes. The above-mentioned products were realising in 1905 the following prices :—

Automobile petrol ... 30 francs per 100 litres.

Hand-lamp petroleum 28 „ „ „

Ordinary lighting

petroleum..... 25 „ „ „

Petroleum carbon..... 50 francs per 100 kilos.

The vaseline was sold in the crude state to firms who make a speciality of refining it. At the time that the writer was in North France the petroleum syndicate were faced with considerable opposition by the Compagnie Industrielle de Petrole who have works at Rouen, Toulon, Rochefort, and other places. This competition decreased the price of automobile petrol from 45 francs to 30 francs per 100 litres. The Raffinerie de Petrole du Nord were fairly successful at this time, although their profits were being diminished by the competition. The works are fully engaged for ten months in the year and are stopped for two months in the summer when work is scarce owing to the decreased consumption of lamp oil. During this interval repairs in connection with the plant can conveniently be made.

In the Raffinerie de Petrole du Nord there was a small chemical laboratory under the control of the manager's son who was works-chemist. He had been educated at the University of Lille, where in fact most of the engineers and technical men controlling the factories of Northern France are trained. The principal work carried out in the laboratory consisted of the determination of the specific gravity of the various oils, and determination of flash point. The method adopted throughout France for determining flash point is as follows: a small vessel in shape and size like an ordinary spirit lamp is fitted with a thermometer; passing over the wick and through the flame of the

paraffin which is to be tested, there is a platinum wire which is bent so that the ends come into contact with the oil in the container of the lamp. When the lamp is ignited the wire is heated which in its turn heats up the oil in the container. As the temperature of the oil increases vapour is formed which mixes with air and ultimately forms an explosive mixture which is ignited by the flame of the lamp. The small explosion which takes place extinguishes the flame and the temperature of the oil is then read on the small thermometer. This indicates the flash point of the oil. For lamp oil, the flash point in France must not be below 35°C .

In this particular establishment about forty men were employed. The products of the French petrol industry are placed on the market under fancy names, such as "Motricine," "Electricine," etc., but these names have no particular significance.

Raw wool is always associated with a certain amount of fatty matter resulting from the perspiration of the animal. It consists of the potash salts of certain organic substances and is known in England under the name "suint," in France "Suane." In the process of washing wool prior to combing, carding, and spinning, these potash salts are extracted from the wool and in former days no effort was made to put them to any particular use. At the present time, however, it is usual to recover these salts in some form or other. Sometimes the liquor from wool washing is evaporated down and the residue calcined so as to form potassium carbonate. A more economical method of wool treatment however is to dissolve out the natural fat by means of suitable organic solvents. In this form it is known as lanoline. The solvent is recovered by distillation and can be used again. Such a method is employed in Belgium by the Société Anonyme le Solvent Belge of Verviers. In Germany also there is a large firm at Martinikenfeld engaged in the manufacture of lanoline products.

In the Department of the Nord the wool washing residues are calcined with the formation of potassium carbonate. At Croix, near Roubaix, there are works devoted almost exclusively to the manufacture of potash salts. This is the Société Anonyme de Croix. As is well known there is a large demand in agriculture for potassium salts as fertilizers. The above-named firm was founded in 1868 and at present time employs about a hundred workmen. The products manufactured consist of caustic potash, potassium chloride, sodium phosphate, hydrochloric acid, and other chemicals. The raw material is derived principally from three sources: Wool-washing residues, beet sugar residues, and salts from the Stassfurt deposits. In the town of Croix there are the large wool-combing works of Isaac Holden et Fils. Isaac Holden came from Yorkshire and introduced the wool-combing industry into France about the middle of the nineteenth century. The works at Croix are still under English management. The Société Anonyme de Croix derive a certain quantity of their wool salts from this firm. The wool washing liquors are evaporated to dryness and sold as such to the potash works. Here it is calcined, in order to remove the superfluous organic matter and the resulting product is potassium carbonate. This can either be sold as such or converted into other potassium salts.

Beet sugar residues, consisting of syrup from which the greater part of the sugar has been extracted by crystallisation, are also used for the manufacture of potash salts. The material is calcined in much the same way as the wool residues. When the beet crop is good a considerable supply of beet sugar residues is thrown upon the market. After several bad seasons, the beet crop in 1905 was exceptionally good and the Société Anonyme de Croix were expecting to derive the benefit. When the beet crop fails and sugar residues are not available in sufficient quantities, the potash salts manu-

facturers keep their plant at work by purifying crude potash salts obtained from the Stassfurt deposits. Transport, however, is expensive, amounting to 30 francs per ton. Potash salts are used extensively in the manufacture of soft soap, glass, and certain artificial manures.

Potash salts are exported from North France to England. Competition however is felt from the chemical manufacturers utilising the Stassfurt deposits on the spot. Lately the electrolytic process has been developed and this form of competition is particularly effective.

CHAPTER VI.

INDUSTRIAL DEVELOPMENT IN GERMANY.

Rapid rise of industry in Germany—Electrical machinery—Chemical industries—Application of science to industry—Incandescent gas mantles—The world's supply of thorium nitrate—The metal filament incandescent lamps—The Tantalum lamp—The Tungsten lamp—The growth of the Krupp firm.

THE industrial development of modern Germany may be stated to date roughly from the time of the Franco-German War. The success of the German Army in 1870, coupled with the federation of the German States which had already taken place, gave an impetus to trade and industrial activity which has aroused the admiration of the whole of the civilised world. Formerly an agricultural country, the German Empire has come to be regarded as one of the leading industrial nations of the world. Whereas Great Britain at one time occupied the leading position in the production of iron and steel Germany has of late years produced these commodities in greater quantities. In mercantile shipping great progress has been made and such lines as the Nord-Deutscher Lloyd of Bremen and the Hamburg-Amerika line of Hamburg, are typical examples of Germany's success in this direction.

In textiles, thriving communities have arisen in Rhineland, Saxony, and Alsace-Lorraine. In the electrical industry recent years have witnessed a remarkable growth. Such firms as Siemens & Halske,

the Allgemeine Elektrizitäts Gesellschaft, and others, have become recognised as leading firms in the production of electrical machinery. The German firms compete successfully in neutral markets with the products of English and American manufacturers.

In the chemical industries Germany has for some time occupied a leading place. Aniline colours and pharmaceutical products are supplied to all parts of the world in large quantities by German manufacturers. The ramifications of the German chemical industry extend everywhere. Although England still continues to be a very large producer of heavy chemicals such as sulphuric acid, soda, tar, soap, etc., most of the finer products are obtained from Germany. To what origin this remarkable development in the German chemical industry is due is not easy to decide. The Germans appear to be particularly adept in applying the latest scientific discoveries to manufactures and in bridging over the gap between pure science and industry to the best advantage. The persevering character of the German, his powers of application, and capacity for hard work, have made up for what he may lack in genius and enterprise. Many of the larger works in Germany are models of discipline, regularity, and orderly routine. The habits of discipline inculcated by a few years of military service in youth are no doubt responsible to some extent for this careful organisation and excellent discipline. Although the German appears in many respects to be less enterprising than the Englishman and the American, there are many instances which show that he is not afraid of taking risks. Consider the large outlay which the German chemical manufacturers make } for research purposes. This may be due to enterprise or to faithful trust in science, but of its successful results there can be no question. Some recent developments have shown that the Germans are not wanting in enterprise when occasion demands. The introduction of the

incandescent gas mantle and the metal filament lamp are examples of this.

It is in the development of new industries that Germany has shown a marked superiority over other countries. The manufacture of aniline dyes which has already been referred to and which is dealt with in detail in later chapters, is perhaps the most striking example of this superiority. It is a little over half a century ago that the birth of this industry took place and to-day the Germans practically control the whole of the world's production. Other examples are not wanting. Less than twenty years ago Auer von Welsbach discovered that certain rare earth oxides might be utilised for imparting luminosity to the Bunsen flame. He invented the incandescent gas mantle and revolutionised the whole aspect of gas lighting which at that time was beginning to be seriously affected by the competition of the incandescent electric lamp. The incandescent mantle was the salvation of gas lighting. It is true that Welsbach was a Viennese and not a German, but it is in Germany that the manufacture of the incandescent mantle has reached its highest development. The mantles are to-day exported to all parts of the world and this industry is a valuable asset for Germany. There are, of course, large quantities of mantles manufactured by the various subsidiary Welsbach and other companies in countries foreign to Germany, but nevertheless it is in Germany that the industry has attained its highest development. Moreover the world's supply of thorium and cerium nitrates, which salts are the basis of the incandescent mantle, is obtained from Germany. The German manufacturers interested in the production and utilisation of these illuminating salts formed themselves into a combine to control the world's supply. The raw material from which most of the thorium is extracted is monazite sand which is found in large deposits in Brazil. Two

Americans, Gordon and De Freytas, obtained the concession from the Brazilian authorities to work these deposits and shipped the monazite sand to Hamburg. It passed into the hands of the German Thorium Convention who for some years have regulated the supply and manipulated prices. Manufacturers of incandescent mantles in other countries must for the greater part of their thorium nitrate requirements be dependent upon the German market.

A new and rapidly developing industry which has many similar features to that of the incandescent gas mantle is the manufacture of the metal filament incandescent electric lamp. To the same inventor who discovered the gas mantle we are largely indebted for the new electric lamp. In 1898 Auer von Welsbach introduced an incandescent electric lamp with a filament of osmium in place of the carbon filament which had reigned supreme during the two previous decades. The Osmiumlicht Unternehmung in Vienna and the Deutsche Gasglühlicht Gesellschaft in Berlin developed the osmium lamp on a large scale but no serious competition was presented to the carbon filament lamp.

In 1905 Dr. von Bolton produced the tantalum lamp which had many features to render it superior to the osmium lamp. The tantalum filament is a drawn wire possessing greater tensile strength than the brittle osmium filament and is cheaper to manufacture and more easily manipulated. The manufacture of tantalum lamps on a large scale was undertaken by Messrs. Siemens & Halske, the well-known electrical firm of Berlin. They were fortunate in securing patent protection amounting to a complete monopoly in this manufacture, and the tantalum lamp has now worked its way into electric lighting to the detriment of the carbon filament lamp.

During the years 1903 to 1906 the tungsten lamp was developed which bids fair to entirely modify the aspects

of electric lighting in much the same manner as the Welsbach mantle did in gas lighting. For the same amount of current the tungsten lamp gives about four times as much light as the carbon filament lamp and twice as much as the tantalum. The principal inventors responsible for the tungsten lamp are Just & Hanaman, Blau, Kuzel, and Lederer, all of whom made their earlier investigations in Vienna. The tungsten lamps are now being manufactured in large quantities by some half-dozen firms in Germany besides other firms in Austria, France, Holland, and the United States. No important inventions in regard to the manufacture of tungsten lamps have so far been made in England, although the lamps are being imported now in very large numbers. The tungsten lamp has undoubtedly come to stay and it appears likely that the manufacture in this country will chiefly be carried out under licence from foreign patentees.

One of the oldest and now the largest manufacturing concern in Germany is the great firm of Krupp. This firm is to Germany what Armstrong, Whitworth & Co. are in England, Creusot in France, and Cockerill in Belgium. Founded in Essen in 1810 by Friedrich Krupp and subsequently carried on by his sons, Alfred Krupp and Friedrich Krupp, the firm was on the death of the latter in 1902 converted into a joint stock company under the title Fried. Krupp Aktiengesellschaft, with a capital of eight million pounds. The shares, however, remained in the possession of the Krupp family. The greater part of the work is carried out at Essen where there were in 1905 over 33,000 people employed. The firm also possesses large blast furnaces at Rheinhausen, iron works at Magdeburg, shipbuilding yards at Kiel, besides numerous collieries and iron ore mines in other localities. The total number of persons employed by the firm amounts to over 60,000. Germany is mainly dependent upon the Krupp firm for her supply

of war material, and other countries also take large quantities of guns, and armour plate. Besides war material a large business is done in rails, girders, wheels, iron plates, tool steel, and other raw material for engineers. At the works at Rheinhausen there were in 1905 six blast furnaces, three of which had a daily output of 250 tons and three of 450 tons. The works at Essen are of a colossal magnitude and form an interesting study in large scale organization. Except in the co-operative stores managed by the firm no female labour whatever is employed, and it is stated that all the employees are of German nationality. The management of the firm is vested in a board of twelve directors, ten of whom are resident in Essen, one in Magdeburg, and one in Kiel.

It is not to be wondered at that Englishmen have thought fit within recent years to give serious study to German methods of industry and organization, and the various commissions which have been sent to that country indicate the respect which we as a nation are beginning to pay to our German competitors. There seems, moreover, to be a tendency lately to give greater prominence to the study of the German language than has been the case in the past. This is another indication that we in England are beginning to study seriously the competition which as a manufacturing nation Germany will give us in the future.

CHAPTER VII.

THE GERMAN CHEMICAL INDUSTRIES.*

Comparison between chemical industry in England and Germany—The aniline colour industry—Photographic Chemicals—The Kartell system in the colour industry—Organization—Research chemists—Technical travellers—Advertising.

THE most striking difference between the chemical industries of England and Germany is that in this country we have mainly developed the inorganic branch of the industry, whereas in Germany most success has been achieved in the organic branch. We have been and are still large producers of alkali, bleaching power, glass, acids, and heavy chemicals in general. The Germans, however, have attained a leading position as manufacturers of aniline dye-stuffs, pharmaceutical products, essential oils, and fine organic chemicals. It is true that the raw material, coal tar, from which the above organic chemicals are mainly derived, is produced in large quantities in this country owing to our abundant supplies of coal. Nevertheless a large proportion of this production is exported to Germany where it forms the basis of their important industry. Our dyeing and printing industries are almost wholly dependent on the German supply of artificial dye-stuffs, the home production being quite inadequate to supply the demand. The immense profits which the German manufacturers have drawn for many years from the sale

* Most of the subject matter of this article was dealt with in an article on the German chemical industries published in the "Times Engineering Supplement" on July 15th, 1908.

of colours in England are out of all proportion to the relatively small profits derived from the sale of coal tar and its intermediate products by British firms.

The most important branch of the chemical industry in Germany is the manufacture of aniline dye-stuffs. Although "mauve," the first aniline dye-stuff produced, was discovered by the late Sir William Perkin in England, a little over half a century ago, and the manufacture of this colour and alizarin was carried out in this country, the development of the industry to its present standard of perfection is due almost entirely to the Germans. The German manufacturers have now acquired almost an absolute monopoly of the whole aniline colour industry. The remarkable success which they have achieved in this branch appears to be largely due to their appreciation of the advantages to be derived from chemical research and the measures they have taken to effectively protect their discoveries by patents.

An important class of fine chemicals manufactured solely in Germany is that of photographic developers. The German chemical manufacturers have secured in this branch of manufacture an absolute monopoly of the production. The large quantities of pyrogallol, hydroquinone, para-amidophenol, metol, and amidol used by photographers in all parts of the globe are produced in Germany. These developers form a lucrative subsidiary manufacture for several of the large colour firms. For instance, the use of para-amidophenol as a photographic developer was controlled by the patents of the Actien-Gesellschaft für Anilin-Fabrikation, of Berlin, who placed an alkaline solution of this body on the market under the name of "Rodinal." This developer is known wherever the art of photography is practised. Another large firm, the Chemische Fabrik auf Actien vorm. E. Schering, have acquired a reputation for the manufacture of pyrogallol. Other firms who manufacture photographic chemicals are E. Merck of Darmstadt,

J. Hauff & Co. G.m.b.H. of Feuerbach, and the Farbenfabriken Fried. Bayer & Co. of Elberfeld. The well-known colour manufacturers, Meister Lucius & Brüning, have lately developed the production of certain dye-stuffs which are used for sensitizing photographic plates to the red and yellow rays. There seems to be no doubt that considerable profit is derived from the manufacture and sale of these fine organic products, especially when it is remembered that the raw materials exist in large quantities in the works producing dye-stuffs. Photographic plates and papers are also produced on a large scale in Germany, but this manufacture is also carried on successfully in England, France, and the United States.

Referring now more particularly to the colour industry in Germany, it appears that the greater proportion of the world's supply of dye-stuffs is manufactured by a few large firms comprised in two groups. There are a number of smaller firms outside these two groups also engaged in the manufacture of colours. A working agreement exists between the members in each group in order to effect desirable economies. One firm, for instance, may be especially strong in producing certain chemicals owing to possession of master patents or particularly efficient plant. The convention provides that this firm shall have a complete monopoly in the manufacture of this product or class of products, but each of the other members of the group stock and sell these products for the convenience of their customers obtaining their supplies from the firm permitted to hold the monopoly. Under this arrangement customers are not encouraged to deal with rival firms and in fact are themselves unaware of the actual origin of many of the products they buy. For instance, some of the German firms include indigo on their price lists, but the actual production of this colour is limited to one or two firms who hold the monopoly.

These inter-working arrangements between the large colour firms tend to greater economy and of course larger profits. In spite, however, of these agreements there is still considerable rivalry between the manufacturers comprising each group, and the interests of each manufacturer are jealously guarded by the selling agents both in the home and foreign markets.

The control of the large chemical works in Germany is mainly vested in the hands of chemists, and it is comparatively rare to find purely financial and commercial men taking any large share in the management. This being the case, the chiefs are fully alive to the importance of new developments and inventions, and can take a larger interest in the organization of the works than if they were merely concerned with the commercial side of the undertaking. Even the selling branches are reinforced by technical men, who understand the production and properties of the various colours, and are therefore able to advise buyers to better advantage than would be the case if they were non-technical men. They are also able to discover and develop new outlets for the firm's products.

The organization of all the large German chemical firms is carried out on very similar lines, and one of the characteristic features is the large amount which is annually devoted to research purposes. Research chemists are employed whose duties are to discover new products and to improve existing methods of manufacture. These men come from the Universities and Technical High Schools direct to the works, being engaged at a comparatively small salary, and their future success is dependent upon their inventive ingenuity and the ability with which they are able to apply their scientific knowledge to manufacture.

A very successful scheme which has been adopted by all the large German colour works is that of marketing their products themselves. By selling colours direct to

the consumer they are able to keep in intimate touch with his requirements. In most countries where chemicals are largely employed, the colour works have their own agents in direct touch with the consumers. In this country the selling organizations consist in several cases of limited companies, the capital of which is ridiculously small compared with the large annual turnover. The principal consumers are dyers, calico printers, wall-paper manufacturers, etc. The selling agents usually receive a small percentage on the total sales, and they are generally engaged to work for their own particular firm and no other. The market for dye-stuffs is very carefully nursed. Technical travellers are employed whose duty it is to instruct consumers as to the best way to use the firm's colours. The technical traveller is often the means of bringing substantial orders to the firm of which he is a member. For instance, a large dyer having little technical training himself and relying upon foremen who do not understand the chemical principles involved in the art, is often faced with difficulties, the solution of which mean the saving of a considerable amount of money. If a technical traveller can overcome some difficulty for a customer he will generally be rewarded by receiving a substantial order for the goods which his firm produces.

The technical travellers are usually of the nationality of the country whose market they are watching and developing. They are in most cases qualified chemists who have spent some months of probation in the experimental laboratories of the firm in Germany. Afterwards they are appointed to a centre, and visit firms in the district, demonstrating the value of the products which they have to sell. When a new colour is placed on the market it is the duty of the technical salesman to explain its nature and advantages to the customers. If a rival firm places new colours on the market they can point out to the customers how to effect a similar result with

existing colours of their own manufacture. In these and similar ways they are able to promote the interests of the firm with whom they are employed.

Apart from fostering the market by the employment of technical travellers, most of the colour firms spend considerable sums annually in advertizing. Handbooks with dyed and printed samples and precise instructions how the dyes and other chemical products are to be used are issued periodically and sent round to the customers. Some dyers say that the instructions in these handbooks generally err in recommending the use of a larger quantity of a dye-stuff than is actually necessary, but most large dyers and printers in this country have their own chemists who are independent of the instructions issued by the colour manufacturers, and are therefore in a position to advise their employers where the colours should be bought. It is in fact highly important for the large dyers and printers to be able to rely upon their chemists in order to buy and use drugs on an economical basis.

CHAPTER VIII.

A GERMAN COLOUR WORKS:
THE FARBENFABRIKEN FRIEDR. BAYER & CO.
OF ELBERFELD.

History of the firm—The works at Elberfeld and
Leverkusen—Products manufactured—Conferences
—Printing and lithographing department—
Description of the Leverkusen works—The Azo
department — Pharmaceutical department — Re-
search laboratories—Patent royalties—Agents'
conferences—Entertaining customers.

ONE of the most successful firms in Germany engaged in the manufacture of colours and pharmaceutical products, is the Farbenfabriken Friedr. Bayer & Co. of Elberfeld. This chemical works may be regarded as typical of a number of similar concerns engaged in the same branch of industry. The firm was originally founded by Friedrich Bayer in the year 1850 at Elberfeld on the banks of the Wupper. In 1881 it was registered as an Aktiengesellschaft under the name Farbenfabriken vorm. Friedr. Bayer & Co. Originally natural colours were dealt with, but with the rise of the artificial dye industry they commenced in 1860 to manufacture magenta. The manufacture of alizarine and allied colours was started in 1871, and later a large number of dye-stuffs and pharmaceutical products were included among the products manufactured.

Although the works occupy a large area in Elberfeld, on both sides of the River Wupper, it was found in

1891 to be impossible to obtain sufficient land in the immediate vicinity of the works to permit of the considerable extension which the progress of the company necessitated. A large site was, therefore, acquired at Leverkusen, which is about five miles north of Cologne on the right bank of the Rhine. The new works at Leverkusen has been planned on a huge scale. Ample provision has been made for the enlargement of the existing plant for many years to come. The headquarters of the firm and offices still remain, however, at Elberfeld, although a large part of the production is gradually being transferred to Leverkusen.

The present prosperity of Elberfeld is in no small measure wrapped up with the success of the Bayer Company. This town is the headquarters of the well-known Bergische-Märkische Bank, which has developed from modest proportions to its present successful position simultaneously with the growth of the Bayer Company. Branch works exist at Schelphoh in Lüneberg, at Moscow, and at Flers, near Roubaix in France, and works are now being erected in England at Port Sunlight in order to conform with the provisions of the Patent and Designs Act of 1907.

The products manufactured by this firm still continue to be chiefly dye-stuffs, of which the following classes may be mentioned: Benzidine colours for direct cotton dyeing, such as benzopurpurine, chrysamine; diazotising colours, para-nitraniline, etc.; wool dyes, such as azo fuchsine, fast green, and the diamond blacks; alizarine colours, especially alizarine blues; sulphur colours for cotton dyeing developed within recent years, such as Katigen Black-brown, Katigen Green, and Katigen Indigo.

A very important branch now being extensively developed is that of pharmaceutical products, such as Phenacetine, the well-known antipyretic, Sulphonal, and Trional, Iodothyrene, Salophen, Aspirine, etc.

A profitable branch has also been introduced in the manufacturing of invalid's and infant's food under the name Somatose. The output of this product is very large. The raw material for this is a bye-product obtained in the manufacture of meat extract consisting of the fibrous material of the meat. It comes in large quantities from Argentine.

Another branch consists in the manufacture of photographic chemicals, such as Edinol, which is a photographic developer, and Acetone-Sulphite.

Much research work is carried out in connection with dyeing and printing. Conferences are held daily at which new processes and inventions are brought before the staff and discussed with reference to their value to the firm. Enquiries, difficulties and problems are continually being received from customers in all parts of the world, and the duty of this department is to give the customers such information as is likely to be of benefit to them, and indirectly to the firm.

Bayer's have large printing departments of their own for making pattern cards, pamphlets, books, labels, etc., which are required in large quantities. Particular attention is paid to the subject of labels in order that they may be able to identify their products in case of necessity. Other manufacturers sometimes imitate the labels, and in order to easily detect imitation special dyes are occasionally employed for printing or lithographing the labels and wrappers which are then easily recognized. For foreign markets labels are printed in the particular language of that country, even in Chinese and Japanese. If the printing is so extensive that it cannot be carried out conveniently in the Elberfeld works it is sent to Leipsic.

The works at Leverkusen cover an estate of about 448 acres, and there is a large open district in the neighbourhood allowing for a further extension and the creation of a garden city for the workmen and employees

of the firm. Bayer's works at Leverkusen is certainly one of the best organized chemical establishments in the world. About 3,500 people are employed at Leverkusen alone, and the works are of such a gigantic nature that this number seems to be lost when a visitor is shown through the works.

The various establishments in the Leverkusen works are set out in streets, some of which are named after distinguished chemists. The writer remembers passing through Bunsenstrasse, Liebigstrasse and Hoffmannstrasse. The works is traversed by a narrow gauge railway facilitating transport from one department to another. In order to permit of easy transport from the narrow gauge railway to the standard gauge railway of the German State Railways, standard trucks are bodily taken on small trolleys running on the works gauge.

One of the most important departments into which the writer was shown was the Azo Department. The production of Azo dyes is an important feature of the firm's activity. The Azo house consisted of a long building with galleries arranged in three tiers on each side. On these galleries stood the vats and cylinders containing the various chemicals required to produce the dye-stuffs. On the lowest level were reservoirs containing compressed air, which is used for transferring solutions from one vessel to another. The vessels containing the raw materials, such as hydrochloric acid, sodium nitrite solution, ice-cooled water, brine, and the compound to be diazotised, were on the top galleries. The dye-stuff when precipitated was forced by compressed air through the filter presses. These were arranged on the opposite side of the bay. Large separate units of plant are reserved for producing one or other of the various stock dyes which are in continual demand.

Several such Azo departments are kept busy at Leverkusen. After the dye-stuff comes from the filter presses

it is taken away to drying ovens in another shed. Trucks are brought along loaded with trays covered with the wet dye-stuff as taken from the filter presses. These trucks gradually pass automatically through the ovens so that they come out when the dye-stuff is dry. The whole arrangement of the department is as automatic as possible. Since the various solutions are forced from one operation to another by compressed air and as the large quantities of dye-stuffs are brought on trucks to the drying ovens, it is possible for a few workmen to manipulate a large quantity of material.

In the pharmaceutical department girls are employed for packing the fine chemicals produced. Very careful organization and supervision is necessary in this department. One class of chemicals is packed in one room, and each group is separated from the rest, so that there shall be little chance of accident arising on account of one product being labelled in mistake for another. The girls are dressed in overalls and are obliged to pay particular attention to cleanliness in order that no danger may arise from contamination of the medical products handled. Some of the chemicals are made up in tablet form and arranged in tubes in the well-known manner.

The Leverkusen works is equipped with a large complete water supply, capable of producing thirteen and a quarter million gallons per day. When it is remembered that the daily consumption of Cologne with its 400,000 inhabitants amounts to thirteen million gallons, the extensive nature of the private Leverkusen water works can be realized.

The manufacture of Azo colours necessitates the use of a large quantity of ice for cooling purposes since the process of diazotisation must generally be carried out at a low temperature. The annual production of ice amounts to over 78,000 tons. This quantity is produced by five large ice machines on the Linde system.

One of the research laboratories was visited. As

pointed out in the previous chapter, the success of the German chemical industry is in a very large measure due to the use which is made of chemical research. The laboratories are arranged very much in the same manner as the University laboratories in this country. Benches and cupboards are provided, and to each bench is led a supply of electricity, compressed air, steam and hot and cold water. The research chemists are paid a salary of about £100 for the first year. If a chemist has shown himself to be useful in his first year, a contract is usually made for a term of years in accordance with his capabilities. The research chemist is also remunerated to some extent by receiving royalties on the output of products manufactured in accordance with processes invented by himself. For instance, the chemist who developed the Somatose products was in receipt of a comparatively small salary, but his royalties on the output of the invalid food invented by him amounted to a large annual sum. It is the policy of the large German colour works to keep the chemists strictly to their own department and not to allow them access to other departments. The object of this is to prevent employees becoming conversant with other than their own work, so that it is less easy for them to carry away secrets to competitors. The contracts under which the employees are engaged are also of a somewhat binding nature. If a chemist desires to leave before the expiration of his contract he cannot as a rule enter the service of a competing firm until the expiration of a prescribed term.

Sufficient coal is always kept in stock to supply the works for three months ahead. During the strike in the Westphalian coal mining industry in 1905 this policy of Bayer's proved of good service. Whilst other works were obliged to close down, Bayer's were able to continue working. The principal acting directors of the *Farbenfabriken vorm. Friedr. Bayer & Co.* at the present time are : *Kommerzienrat Friedrich Bayer, Landtagsabgeordneter*

Dr. Henry T. Böttinger, and Professor Dr. Carl Duisberg.

A good deal of welfare work is carried out by the Bayer Company for the employees and workmen in the way of long service premiums, savings bank and sick funds. A garden city is springing up in the vicinity of the works at Leverkusen.

Every five years the various agents of the Bayer Company in all parts of the world meet at Elberfeld and discuss the policy and development of the business. On such occasions about two hundred agents meet together, when papers are read and discussions held with a view to developing the different aspects of the Company's business. The hotels at Elberfeld are usually full when the Bayer Company hold a meeting of this sort. Naturally great secrecy is maintained as to the subjects discussed at such conferences.

The Farbenfabriken Friedr. Bayer & Co. usually entertain their customers well when visiting Elberfeld. They are taken through the works there, or at Leverkusen, and the various processes in which they are interested explained to them. In this way clients become interested in the business and are induced to place future orders with the Company. Important customers in this country taking a trip up the Rhine or through Germany will often take the opportunity when passing through Cologne to give Bayer's a visit.

CHAPTER IX.

DYEING IN WESTERN GERMANY.

Location of the dyeing industry—The Barmen trade—
Artificial silk in the Barmen trade—Bartels
Dierichs & Co.—House industry—Small proprietors
—Silk dyeing—Conditioning House—Testing silk.

THE dyeing industry of Germany is mainly located in Saxony, Alsace-Lorraine, and Western Germany. The following observations refer to Western Germany, particularly Barmen and Elberfeld. Another town in this region, Crefeld, is gradually becoming an important centre for silk, and in that town and München Gladbach, a large amount of silk dyeing is carried out. An important dyeing school is located at Crefeld.

In Elberfeld and Barmen there exist one or two large dye-works, but the majority of dyers are proprietors in a small way, catering especially for the Barmen trade. Barmen is a noted centre for the manufacture of trimmings, braids, ribbons and similar articles, used chiefly in ladies' apparel. This necessitates the use of dyed hanks to a large degree. In the composition of braids a large number of miscellaneous yarns and fibres are used, such as wool, cotton, silk, both natural and artificial, linen, ramie, mohair, besides brass and other metal wire. In the district there are many dyers who specialize in one particular branch of yarn dyeing.

Situated midway between Barmen and Elberfeld is the very large calico printing works of Schlieper and Baum. This firm is said to be the largest firm of calico printers in Germany, although the designs are not so fine and elaborate as those produced in Alsace-Lorraine.

A well-known firm engaged in the Barmen trade is Messrs. Bartels Dierichs & Co. They have a large factory and offices of comparatively recent erection near the Wupperfeld station on the Schwebebahn. Their products include ribbons, hat-bands, braids and trimmings of all kinds. They do not dye any of their own material, this being done by the numerous small dyers in the vicinity. It was noticed that a large quantity of artificial silk entered into the composition of trimmings and braids manufactured by this firm. Some of the artificial silk came from the well-known Belgian firm, the Société Anonyme de la Soie Artificielle de Tubize. The artificial silk previously came into the country untaxed, but in 1906 an import duty of 30 pfennigs per kilo. was imposed. A prominent gentleman in Messrs. Bartels Dierich & Co. did not speak well of the introduction of this tax. The German industry of artificial silk is in no need of protection for the Frankfort firm make annually several millions of marks in profit. The German artificial silk does not compare, however, in appearance with the Belgian variety, the latter being whiter and more brilliant in appearance, so that it takes dyes of a delicate shade to greater advantage. A variety of artificial silk which is coming largely into use in the manufacture of Barmen braids is a type resembling mohair. It is prepared in precisely the same way as ordinary artificial silk, the only difference being that the material is squirted through dies of larger aperture, so as to give threads of greater cross-section. This material has a more brilliant appearance than mohair, in fact it is more glossy than horsehair. It does not, of course, possess the tensile strength of the natural fibre. In producing trimmings, however, this is of little consequence. It is largely used for black materials, especially mourning goods.

Although Bartels Dierichs & Co have large workshops and many looms of their own, they also control a large

home industry. The inhabitants of Barmen have for centuries manufactured with hand looms the products for which the district has a reputation. The work has been carried out at the homes of the workers. The introduction of power machinery has tended to concentrate the production into factories, and the main proportion of the production of this district probably now emanates from this source. The home industry, however, has not been entirely ousted, and still survives in many of the older families of the district. In some cases small gas engines or small electric motors have been installed to work the family looms, and where there are several adults in one family, the combined wages often amount to sufficient to keep the family in comfort. The workers in such cases obtain their raw material at the beginning of the week from the factory and return it in the finished form, being paid according to quantity. The workers in this neighbourhood are of an independent and intelligent disposition, somewhat resembling the population of Lancashire. The dyers are mostly small proprietors employing twenty to fifty hands. These men are usually characterized by considerable independence of spirit, being shrewd and in their particular line progressive and enterprising. They are sometimes travelled men speaking one or more foreign languages besides their native tongue.

A typical dye-works visited by the writer was that of Hugo Kaulen in Elberfeld. The work consists of hank dyeing, particularly natural and artificial silk. The proprietor was educated in Milan. Although quite a small works, a comparatively large number of hands were employed because all the operations were manual. Machinery in works like this would not be of great advantage because the Barmen trade requires few stock lines and necessitates the use of coloured threads of very different shades. A dyer receives a large number of small orders for dyeing different varieties of yarn

in various shades. The success of such a works therefore depends largely upon what is called rule-of-thumb knowledge. The proprietor of such a small works generally controls the whole business both on the practical and commercial sides, and lives in the vicinity of the works.

In silk dyeing the hanks must usually be washed in order to remove the gummy matters. Italian silk, for instance, has about 30 per cent. of gum, and the first treatment consists of boiling off this gum in a heated bath containing a solution of soap. During this treatment the silk loses its harsh feel and becomes soft and white. After washing to remove the soap, the silk is dyed to shade. A washing machine was seen in operation equipped with spindles of earthenware material on which the hanks were suspended. When the machine was started the spindles revolved and water was spurted from apertures on to the hanks, washing them quickly. Such a machine gives excellent results where water is plentiful. Artificial silk, of course, requires no boiling since it contains no size, and can be dyed directly. It is worth mentioning, however, that artificial silk requires very careful treatment on account of its low tensile strength. It is necessary that it should be dyed as quickly as possible. An interesting mixed-dyeing process was being carried out. A number of hanks were dyed different colours on the same stick. One part of the hank was dyed blue, another red and another green with white undyed spaces between each colour. Such multi-colour hanks are used in the manufacture of mixed ribbons. In the construction of the dye-baths the wood was lined with canvas in order to prevent materials from catching on the splinters; for instance, silk hanks are easily damaged in baths with a splintered surface. After dyeing and washing the material was hydro-extracted and afterwards dried in a drying-oven at a temperature of about 60°C. a strong current of air being

maintained at that temperature. The hanks were packed somewhat close together, and took about three hours to dry.

There are two important conditioning houses in Western Germany, one in Crefeld and the other in Elberfeld. These institutions are of a similar nature to the conditioning house at Roubaix described in another chapter, the principal difference being that at Roubaix they are chiefly engaged with wool testing, whereas at Crefeld and Elberfeld more silk passes through the establishments. Raw silk varies considerably in quality, so that it is generally necessary to base all contracts between vendors and purchasers on the conditioning house reports. The cost of the report is shared by the two parties. At Elberfeld a large residential mansion in the Hofaue Strasse has been converted, at a cost of about £15,000, into a well-equipped conditioning house. This establishment, and also the one at Crefeld, are modelled on the same lines as the conditioning house at Milan. On the ground floor one large room is reserved for sampling and weighing the bales of material, whilst other rooms are devoted to moisture estimation, breaking and elasticity tests, etc. In the basement there is a furnace for heating the hot air blast used in the moisture determination; other cellars are used for storage purposes.

In testing silk a determination which is often made is that of the "titre." This coefficient represents the weight of a unit length of the raw silk. A length of the silk is wound off on a cylinder of known dimensions to which a counting mechanism is attached recording the number of revolutions. The length wound off is afterwards weighed and the "titre" calculated from the results. Another determination which is sometimes required by the silk manufacturer is the breaking factor. The raw silk is wound off on a machine under a predetermined tension, and the number of times the thread

breaks during one hour is recorded. The machine automatically stops each time the thread breaks, and is then set in motion again by the attendant. This factor gives some indication to the manufacturer of the tensile strength of the silk, and he can more readily determine the treatment it will require in manufacture. Artificial silk does not usually pass through the conditioning house, but all varieties of natural silk are dealt with, especially Bengal, Chinese and Japanese silk. On account of the large development of the silk trade in Western Germany within recent years the conditioning house is always kept busily employed.

CHAPTER X.

PATENT PROTECTION.

German patent system—The German Patent Office Search — Anticipations — Fees — Proceedings in opposition to grant of patents—Grounds for opposition to grant—Value of patent when granted—Abuses of patent protection—Patents in the German chemical industry—Extent of monopoly obtained by patent protection—Practice of German manufacturers prior to Patents and Designs Act of 1907—Effect of New Act—Expenditure on patents—Patent Bureaus.

IN referring to the marvellous progress which the German chemical industry has made during the last few years, and comparing the same with the stagnant condition of the industry in this country, it has been asserted by responsible authorities that this state of affairs is in some measure due to defects in our patent laws. In the present chapter an attempt is made to analyse this question with a view to ascertaining how far these statements are true, and whether the Patents and Designs Act of 1907 is likely to ameliorate the condition of the chemical industry in this country.

For many years Germany has been favoured by the administration of patent laws on a sound and enlightened basis. Those who are engaged in patent practice are not long in recognizing that the German procedure is undoubtedly superior to that of other countries, and the tendency in recent years has been to agitate for a

modification of the English practice so as to make it resemble more closely that which is adopted in Germany.

When a German inventor has conceived an idea which he considers will improve upon an existing product, machine or process, he makes an application for a patent. The filing fee is very moderate, only amounting to £1. The application is examined by the Patent Office staff, who make a search in order to ascertain whether the invention is anticipated. This search extends not only to German specifications and technical literature, but also to the specifications and technical literature of other countries. The search therefore is much more thorough than that adopted by the British Patent Office, which only extends to British specifications published not more than fifty years prior to the date of the application. When the search is complete the German Examiner issues an official letter to the applicant informing him how far his invention is anticipated, and if novel features have been disclosed he usually indicates the scope of claims which might be allowed. The applicant may, in view of references cited, be called upon to file amended documents with claims of more limited scope. If the application shows no novel feature it is formally rejected.

The German official letters stand in marked contrast to those issued by the Comptroller of the Patent Office here, who, after the search has been made, issues a printed official letter merely citing references in anticipation and rarely offering suggestions to the applicant as to the novelty of the invention. Moreover, the Patent Office will seldom refuse an application for a patent, even if there is for all practical purposes complete anticipation. Thus there are far more worthless patents granted in this country than is the case in Germany, where the Office has no hesitation in rejecting the application in cases where it is obvious that no invention has been shown over the existing knowledge. Since the filing fee of £1 in Germany is

so moderate, no great hardship is inflicted on the applicant by the rejection of his application, if sufficient invention has not been shown. In England the filing fees are heavier, amounting to £4 for an application accompanied by a complete specification. Thus an inventor in England, in order to obtain the benefits of a search to ascertain whether he is in possession of an invention, must pay four times as much as the German inventor, and even then the search made by the English Patent Office is of far less value to him than that of the German Office. In view of the superiority of the German search, it is a frequent practice among inventors in this country who file many applications for patents to first file the application in Germany in order to get the benefit of the search, and if favourable to then file application in England and other countries, claiming the priority of the German application under the International Convention. This is better than wasting money in filing applications in several countries for an invention which may be completely anticipated.

Another feature of the German practice which might well be adopted in this country is the facilities which the public are allowed in opposing the grant of a patent. Whereas in England the grounds on which opposition may be raised to the grant of a patent are greatly restricted, in Germany the practice is much more flexible so that the public, that is to say rival manufacturers, come to the assistance of the German Patent Office in assuring that patents shall only be granted for *bona fide* inventions of real novelty and utility. Thus, in Germany an application for patent may not only be opposed on the ground of anticipation by a prior publication, but also on the ground of prior user, and on the ground that the specification as laid open for public inspection does not comply with the section of the patent law which requires a full disclosure of the invention. In cases where prior use of the invention is alleged, witnesses are usually

examined by the Patent Office. If it can be proved, moreover, in opposition that the process described in the specification does not in practice lead to the alleged result, then the patent is refused.

Numerous cases are known where applications for patents have been simultaneously filed in England and Germany for an invention of doubtful novelty, that whereas the English application has gone through the Patent Office without much difficulty and a patent has been granted, the German application has either been rejected or a patent has been refused in view of a justifiable opposition. In fact, so much use is made in Germany of the facilities for opposing the grant of a patent, that an invention of value which is likely to be of considerable utility to the owner must usually withstand the most severe and persistent attacks of rival manufacturers in whose interests it is that a patent should not be granted. The result of this is that a patent when ultimately granted in Germany represents an asset of more real value to the owner, and upon which, in cases of infringement, he can sue with greater confidence of success than is the case with an English patent. In view of the criticism of the examining staff and the strenuous oppositions of competitive manufacturers, it generally happens that doubtful features of the specification and claims which would make the patent when granted invalid, are cut out before a final grant is obtained. A German patent leaves less controversial features to be fought out in the law courts in cases of infringement than is the case with an English patent.

Under the system prevailing in England at the present time it is possible for a manufacturer to obtain a patent for some article which has been manufactured before, and in which perhaps he has made some little modification involving little or no inventive ingenuity. He is thus enabled to stamp the words "patent" on the article and frighten off other would-be manufacturers in cases

where he would stand no chance of success in an action for infringement. To contest a law suit involving heavy expenses is no great boon to many small firms, and manufacturers sometimes profit by this to obtain a monopoly to which they are in no wise entitled. Such occurrences are less frequent in Germany, where fewer worthless patents are granted, and there seems to be no doubt that the lax system prevailing in this country leads to abuse which would not be possible were the more stringent German system to be adopted.

With regard to other countries, the practice in the United States, Austria, and the Scandinavian countries resembles that of Germany. In France, Italy, Spain, Portugal and all the British colonies with the exception of Canada, there is no official examination with regard to novelty.

It has been the policy of all the large German chemical manufacturers to take the most effective steps possible to protect their manufacture by means of patents. Employing large staffs for the purpose of discovering new products and methods of manufacture, it has not been difficult for them to secure the full measure of protection which the patent laws of different countries afford the inventor. In the manufacture of aniline dyes it may safely be asserted that most of the important colours have been manufactured and exported to other countries under the benefits of a complete monopoly secured by patents. The German manufacturers have taken full advantage of the rights conferred by the patents. They have usually preferred to exploit their monopoly entirely by themselves, and have seldom permitted foreign competition by granting chemical manufacturers in other countries licences to manufacture under their patents. With well-equipped factories at their disposal it has been possible for them to work a patented process to a sufficient extent to supply the whole of the demand themselves. In countries where the patent laws require

every patent to be worked in the country by the patentee they have erected branch establishments in which they carry out just sufficient of the patented processes to conform with the requirements of the law. This foreign manufacture by the German chemical firms in order to secure the "working" of their patents must, of course, be considered apart from those cases where an import tariff has necessitated the erection of a foreign factory. Before the Patents and Designs Act, 1907, came into operation in England, the German colour manufacturers were able to exercise an enormous monopoly by the sale of patented colours in this country. We are the largest customers in the world for colours, and nearly the whole of our supply was imported from Germany. The new Act is intended to remedy this anomalous state of affairs, and in return for the monopoly which our patent laws grant to the inventor for a term of years, it will be necessary for him, whether a British subject or a foreigner, to work the patent to an adequate extent in this country. Otherwise the monopoly is liable to be taken from him by the revocation of his patent at the instance of a competitor. There are already indications that the German colour manufacturers are taking steps to erect works in this country in order to comply with the provisions of the new Patent Act. This cannot fail to improve employment in this country owing to the introduction of foreign capital, and the British chemical industry will experience in due course a well-needed stimulus from this source.

Rich foreign firms to whom the English market is a valuable consideration will not hesitate to erect branch works in this country, or at any rate finance companies in order to secure a proper and sufficient working of their English patents. No doubt the greater part of the profits will revert to the foreign owners, and in many cases the higher posts in the establishments will be allocated to foreigners, but British labour, even if largely

unskilled, will be employed, and there is a likelihood of raw material being purchased in this country to a greater extent than formerly. This will be to our benefit. In other cases, however, there will be many smaller foreign manufacturers who have not sufficient capital to work their English patents themselves, and who will be satisfied to sell their patent rights entirely, or grant licenses to English firms. In such instances very real material benefit will be secured by capital and labour in this country.

The public generally do not realise to what an extent an industry depends upon patents. Improvements in machines and processes in every branch of manufacture form subject matter for patents. In the chemical industry particularly patents are of paramount importance. Although most chemical works are conducted under conditions of secrecy it is almost always imperative to protect every new improvement by means of patents not only at home but in foreign countries as well. Competition is so keen and imitation so prevalent that a new process cannot long be kept secret. The drawing up of specifications and claims and the various intricacies of international patent practice form work for professional patent experts. It is generally necessary for an inventor to employ the services of a patent agent. The various fees in connection with patent applications and the renewal fees for maintaining a patent, together with the charges made by the patent agent for his expert assistance, make a considerable item in the expenditure of a large manufacturing firm. As has already been pointed out, the German colour industry has been maintained largely under the protection afforded by its patents. It is difficult to estimate the expenditure on patents made by individual firms, but some idea of the importance of this subject to the German firms may be gained by a study of the following tables, in which the patents granted in Germany and applied for

in England by a number of the more important firms are indicated :—

GERMAN PATENTS GRANTED IN 1907.

Badische Anilin und Soda Fabrik, of Ludwigshafen	56
Farbwerke vorm. Meister Lucius & Bruning of Hoechst-on-Main - - - - -	49
Farbenfabriken Friedr. Bayer & Co. Elberfeld -	46
Aktien-Gesellschaft für Anilin-Fabrikation, of Berlin	30
Kalle & Co. of Biebrich - - - - -	30
Cassella & Co. Frankfort-on-Main - - -	14
Gesellschaft für chemische Industrie in Basel -	14
E. Merck, Darmstadt - - - - -	10
Chemische Fabrik von Heyden Aktien-Gesellschaft of Radebeul - - - - -	10
Knoll & Co. of Ludwigshafen - - - -	10
*Chemische Fabrik Griesheim-Elektron - - -	8
Chemische Fabrik auf Actien, vorm. E. Schering, Berlin - - - - -	8
Schimmel & Co., Chemnitz - - - - -	5

Clayton Aniline Co. of Manchester - - -	1
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The above list comprises the more important German firms manufacturing organic chemicals, such as dye-stuffs, pharmaceutical and medicinal products, etc. During 1907 there were very few German patents in this particular branch granted to English applicants. If now we turn to England, we find that the following applications were made by the principal firms :—

* The Chemische Fabrik Griesheim-Elektron also acquired eight other patents during 1907.

ENGLISH PATENTS APPLIED FOR IN 1907.

Farbwerke vorm. Meister Lucius and Bruning,	
Hoechst-on-Main - - - - -	35
Farbenfabriken vorm. Friedr. Bayer & Co., Elberfeld	33
Badische Anilin und Soda-Fabrik, Ludwigshafen -	27
Gesellschaft für chemische Industrie in Basel -	19
Actien-Gesellschaft für Anilin-Fabrikation, Berlin -	15
Chemische Fabrik Griesheim-Elektron, Frankfort-	
on-Main - - - - -	10
Cassella & Co., Frankfort-on-Main - - -	7
Kalle & Co., Biebrich - - - - -	4
Chemische Fabrik auf Actien vorm. E. Schering,	
Berlin - - - - -	3
Levinstein Ltd., Manchester - - - - -	6
Clayton Aniline Co., Manchester - - - - -	5
Read Holliday & Sons, Huddersfield - - -	5

It will be seen therefore that the applications made by German firms far outnumber those made by English firms in this important branch of the chemical industry. It should be noted too that a firm will usually protect an invention at home before seeking protection in foreign countries.*

Most of the German colour manufacturers have their own patent departments, and employ technical and legal experts for the purpose. This system is preferable to employing a regular agent in ordinary practice since it is difficult to find a patent agent of repute who does not work for several firms in competition with one another. By having their own patent bureau a firm can not only effect economies but can also specialise in their own branch, and therefore look after their own interests,

* These two tables are compiled from the official German "Patentrolle" and the English Index respectively.

better than the ordinary patent agents engaged in general practice are in a position to do.

The patents of competitive manufacturers are carefully watched and their specifications kept on file. The system which many large German firms have adopted of employing their own patent experts appears to give excellent results, but has not been applied to any large extent in this country. One or two important electrical firms here have their own patent bureaus, but most of the patent work of manufacturing firms in this country passes through the hands of chartered patent agents in ordinary practice.

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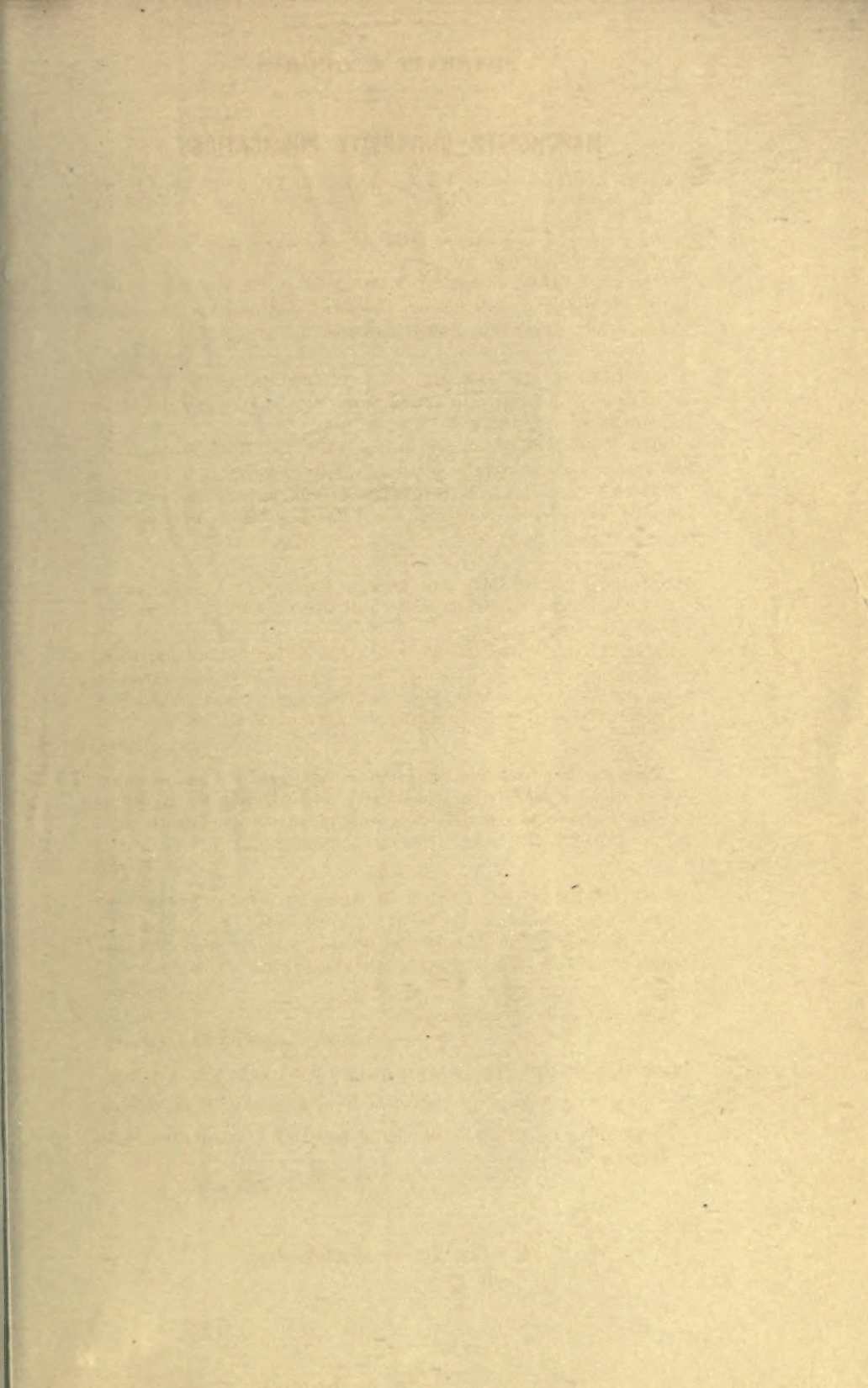
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